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THE POSTLARVAE AND JUVENILE STAGES OF TWO
SPECIES OF *PSEUDOSQUILLOPSIS* (CRUSTACEA,
STOMATOPODA) FROM THE EASTERN PACIFIC
REGION

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This report was prompted by a study of the West African stomatopods in which two gonodactylid postlarvae, 30 to 33 mm in length, were encountered in collections from the Gulf of Guinea. These specimens resembled members of the genera *Parasquilla* and *Pseudosquilla*. One of these had been identified by Schmitt (1926) as the postlarva (first littoral stage) of *Parasquilla ferussaci* (Roux, 1830) although it differs in several respects from an earlier account of the postlarva of that species by Giesbrecht (1910).

As a result of comparing these specimens with the postlarvae and adults of other members of the family, their identity has been established, diagnostic characteristics of the postlarvae of *Pseudosquilla* can be summarized, and four species can be recognized in the genus.

Prior to this study, the genus *Pseudosquilla* was considered to comprise three species: *P. cerisii* (Roux, 1828) from the Mediterranean Sea, *P. dofleini* (Balss, 1910) from Japan, and *P. lessonii* (Guérin, 1830) from the eastern Pacific region (Serène, 1962; Manning, 1963). Two additional species, *P. monoceros* (H. Milne-Edwards, 1837), from Chile, and *P. marmorata* (Lockington, 1877), from California, have been described, but most authors including Miers (1880), Bigelow (1894) and Schmitt (1940), synonymized these species with *P. lessonii*, usually without comment. However, Miers did note (1880, p. 114) that "*P. marmorata*, Lockington (P. Cal. Ac. Sci.

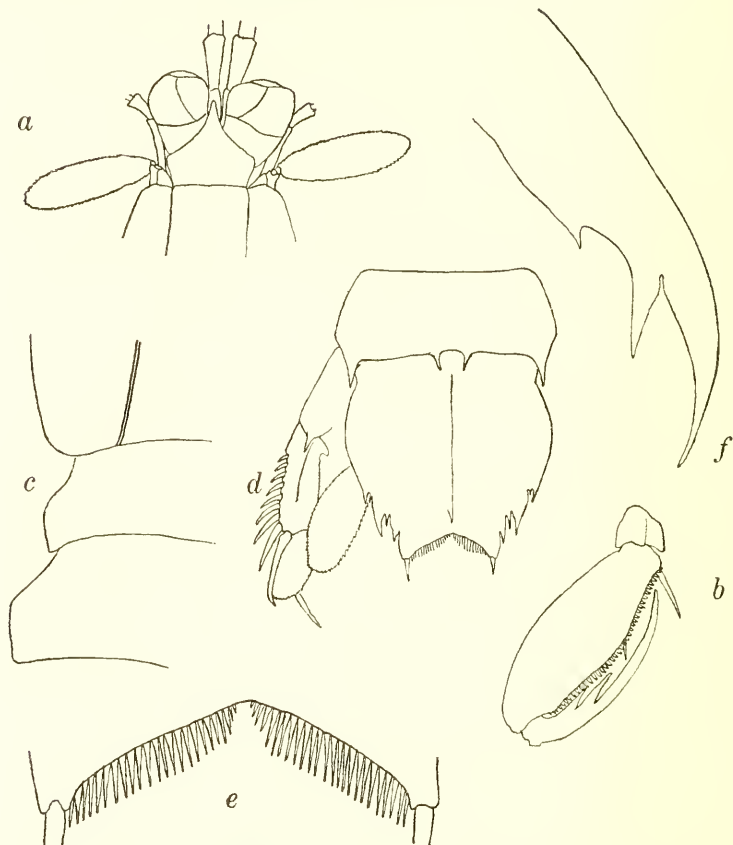


FIGURE 1. *Pseudosquilla marmorata* (Lockington), female postlarva, TL 26.5 mm: *a*, anterior portion of body; *b*, raptorial claw; *c*, lateral processes of sixth and seventh thoracic somites; *d*, sixth abdominal somite, telson, and uropod; *e*, submedian denticles of telson; *f*, basal prolongation of uropod. (Setae omitted).

p. 33, 1877), from San Diego, California, either belongs to this species [*lessonii*] or is very closely allied to it."

The postlarvae and juveniles treated here clearly show that two species of *Pseudosquilla* occur in the eastern Pacific region, and *P. marmorata* (Lockington) is recognized as a distinct species.

In their postembryonic development, all stomatopods seem to possess a single postlarval stage, at the termination of their

pelagic larval life. The larval-postlarval molt results in dramatic structural changes involving a transition toward the characteristic facies of the benthic adult stages (Manning, 1962; Alikunhi, 1967). In many species, postlarvae can be correlated with the adult only by rearing them as was done by K. H. Alikunhi (1967) in India. Bigelow (1931) was able to associate the postlarvae with the adults of several different species of *Pseudosquilla* in the Indo-West Pacific region without utilizing rearing techniques. Studies on the postlarvae are badly needed to provide basic ontogenetic information in the stomatopods and to allow the specific identification of the postlarvae of each species. In addition, postlarval characters may augment or help to clarify concepts of interspecific relationships.

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All specimens are in the collection of the Division of Crustacea, National Museum of Natural History, Smithsonian Institution.

POSTLARVAL STAGES OF EASTERN PACIFIC
PSEUDOSQUILLOPSIS

Pseudosquillopsis marmorata (Lockington, 1877)

Squilla marmorata Lockington, 1877, p. 33. [Type-locality: San Diego, California].

Figure 1

Material: 1 ♂, 29 mm¹; 2 ♀, 27–28 mm; Bahia Ballenas, Baja California; 3 May 1888; *Albatross*.— 1 ♂, 25 mm; 4 ♀, 25–27 mm; Bahia San Roque, Baja California; 9–10 February 1950; L. McHugh.— 1 ♀, 27 mm; San Carlos Bay, Gulf of California; electric light hung over side at night at anchorage; 30 March 1940; E. F. Ricketts.— 1 ♀, 28 mm; Gulf of California; University of California; LXXXIII-H1.— 1 ♂, 28 mm; same; LXVII-H1.

Description: TL 25–29 mm; cornea trilobed, inner portion subdivided into 2 lobes (Fig. 1a); antennular peduncle 61–75 percent of carapace length; width of antennal scale 26–36 percent length; rostral plate pen-

¹In the postlarvae of *Pseudosquillopsis*, at least, males can be recognized by the presence of the buds of the copulatory tubes at the base of the third pair of walking legs.

TABLE 1. Summary of basic data for postlarvae and juveniles of *P. lessonii* and *P. marmorata*.

	Postlarvae		Juveniles	
	<i>lessonii</i>	<i>marmorata</i>	<i>lessonii</i>	<i>marmorata</i>
Number of specimens	2	10	1	1
Total length (mm) (TL)	30-32	25-29	35	40
Carapace length (mm) (CL)	5.7-6.0	4.8-5.4	6.7	7.7
Corneal index: range	356-375	327-386	—	—
mean	365	365	335	335
Antennular peduncle, as percent CL: range	75	61-75	—	—
mean	75	66	87	78
Antennal scale width, as percent length: range	37-38	26-36	—	—
mean	38	33	29	23
Distance between submedian teeth of telson, as percent telson width: range	38-46	46-56	—	—
mean	42	50	36	30
Submedian denticles of telson	17	21-25	—	17

tagonal, length and width subequal, apex not extending beyond cornea, anterolateral angles rounded (Fig. 1a); carapace lacking carinae; superior margin of propodus of claw pectinate, dactylus of claw with 3 well-formed teeth (Fig. 1b); exposed thoracic somites lacking lateral carinae, lateral processes of sixth and seventh somites rounded laterally, angled posteriorly (Fig. 1c); anterior 4 abdominal somites unarmed, fifth abdominal somite with posterolateral spines; sixth abdominal somite not carinate, with 2 pairs of posterior spines, intermediates absent (Fig. 1d); telson with median carina, remainder of carinae absent (Fig. 1d); submedian teeth of telson widely separated, 20-25 submedian denticles present on inner surface of each submedian tooth (Fig. 1e); basal prolongation of uropod produced into 2 spines, outer longer, with smaller third spine on inner margin, remainder of inner margin smooth (Fig. 1f).

Pseudosquilla lessonii (Guérin, 1830)

Squilla lessonii Guérin, 1830, pl. 4, fig. 1; 1838, p. 40 [*S. cerisii* in text]
[Type-locality: Peru].

Figure 2

Material: 1 ♂, 32 mm; 1 ♀, ca. 30 mm; Punta Carretas, Peru; in stomachs of *Neothunnus macropterus*, *Katsuwonus pelamis*, *Sarda*; Enrique M. del Solar.

Description: TL 30-32 mm; cornea trilobed, inner portion subdivided into 2 lobes (Fig. 2a); antennular peduncle 75 percent of carapace

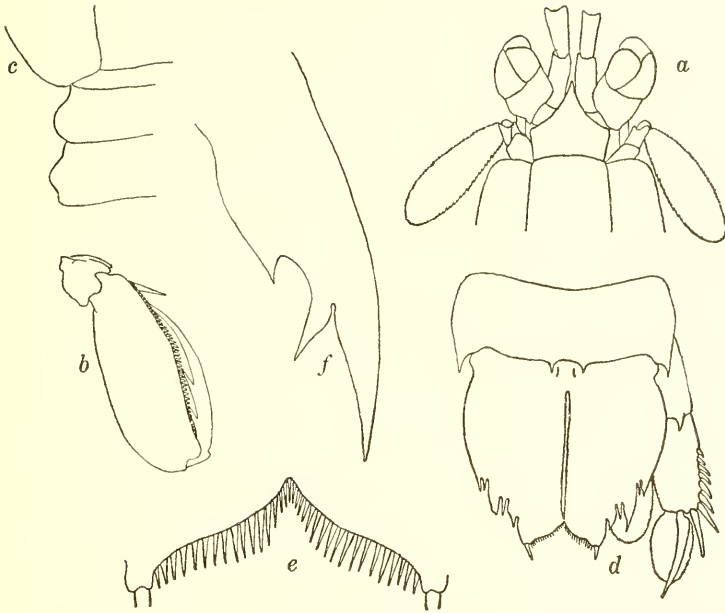


FIGURE 2. *Pseudosquilla lessonii* (Guérin), male postlarva, TL 32 mm: *a*, anterior portion of body; *b*, raptorial claw; *c*, lateral processes of sixth and seventh thoracic somites; *d*, sixth abdominal somite, telson, and uropod; *e*, submedian denticles of telson; *f*, basal prolongation of uropod. (Setae omitted).

length; width of antennal scale 37–38 percent length; rostral plate pentagonal, length and width subequal, apical spine not extending beyond cornea, anterolateral angles rounded (Fig. 2*a*); carapace lacking carinae; superior margin of propodus of claw pectinate, dactylus of claw with 3 well-formed teeth (Fig. 2*b*); exposed thoracic somites lacking carinae, lateral processes of sixth and seventh somites rounded (Fig. 2*c*); anterior 4 abdominal somites unarmed posterolaterally, fifth somite with posterolateral spines; sixth abdominal somite with 2 pairs of posterior spines, intermediates absent; posterolateral spinule present (Fig. 2*d*); telson with single median carina, submedian teeth of telson widely separate, 17 submedian denticles present on inner surface of each submedian tooth (Fig. 2*e*); basal prolongation of uropod produced into 2 spines, outer longer, with smaller third spine on inner margin, remainder of inner margin smooth (Fig. 2*f*).

COMPARISON OF POSTLARVAL STAGES

The postlarvae of both *P. marmorata* and *P. lessonii* can be recognized as postlarvae by the form of the cornea, for the cornea is trilobed in that

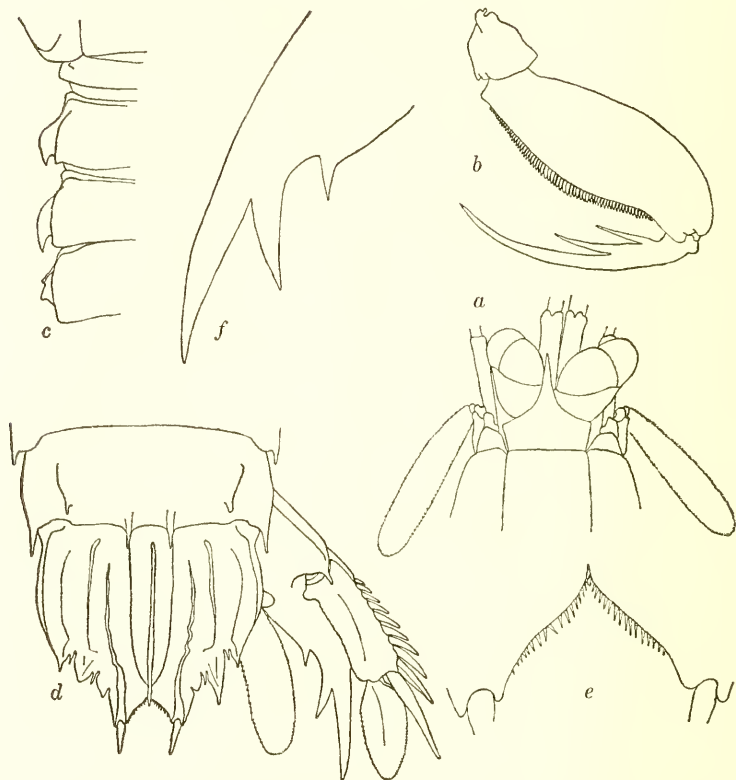


FIGURE 3. *Pseudosquillopsis marmorata* (Lockington), juvenile female, TL 40 mm: *a*, anterior portion of body; *b*, raptorial claw; *c*, lateral processes of exposed thoracic somites; *d*, sixth abdominal somite, telson, and uropod; *e*, submedian denticles of telson; *f*, basal prolongation of uropod. (Setae omitted).

stage of both species. The cornea (Figs. 1*a*, 2*a*) is divided into inner and outer half by a longitudinal line of cells, and the inner half is further subdivided into two lobes. The shape of the eye is characteristic of the postlarval stage in this genus.

The postlarvae can be identified with *Pseudosquillopsis* by the pentagonal rostral plate, ornamented anteriorly with a long apical median projection, the presence of pectinations on the propodus and three well-formed teeth on the dactylus of the raptorial claw (Figs. 1*b*, 2*b*), and the form of the basal prolongation of the uropod which terminates in two distal spines with a smaller spine on its inner margin (Figs. 1*f*, 2*f*).

The postlarvae of species of *Pseudosquilla* differ from those of *Pseudosquillopsis* in having a slenderer raptorial claw with the propodus lacking pectinations and dactylus unarmed (the monodactyla stage) and in having the basal prolongation of the uropod terminate in two spines with no additional spines on the inner margin. The postlarvae of species of *Parasquilla*, which as adults resemble *Pseudosquillopsis* in many features (Manning, 1963), differ from those of *Pseudosquillopsis* in having a short, rounded rostral plate.

As in the postlarvae of many other species of gonodactylids, the telson in *Pseudosquillopsis* postlarvae lacks most of the dorsal ornamentation characteristic of adults; only the median carina is present. The carination and spination of the sixth abdominal somite are similarly reduced, for in the postlarvae only the submedian and the lateral spines are present, the intermediates being absent, and the spines that are present are not mounted on carinate ridges.

The postlarvae of *P. marmorata* may be distinguished from those of *P. lessonii* by several features. First, the postlarvae of *P. marmorata* are smaller than those of *P. lessonii*; the 10 specimens of *marmorata* available for study range in total length from 25 to 29 mm, whereas the two specimens of *lessonii* examined possess total lengths of 30 and 32 mm. The carapace lengths of the postlarvae of *marmorata* range from 4.8 to 5.4 mm, whereas the carapaces of the two specimens of *lessonii* measure 5.7 and 6.0 mm. The antennal scale of *marmorata* is slenderer than that of *lessonii*, for in the former species the width of the scale is 26–36 percent of the length, whereas in *lessonii* it is 37–38 percent of the length. The apices of the submedian teeth of the telson are further apart in *marmorata* than *lessonii*; in *marmorata* the distance between the submedian teeth ranges from 46–56 percent (mean 50 percent) of the telson width, whereas in *lessonii* the distance between the submedian teeth is 38 and 46 percent (mean 42 percent) of the telson width.

The best feature for distinguishing postlarvae of the two species is the shape of the lateral process of the sixth and seventh thoracic somites. In *marmorata* (Fig. 1c) these processes are flattened laterally and angled posterolaterally, whereas in *lessonii* (Fig. 2c) they are broadly rounded laterally and posterolaterally.

JUVENILE STAGES OF EASTERN PACIFIC *PSEUDOSQUILLOPSIS*

Pseudosquillopsis marmorata (Lockington)

Figure 3

Material: 1 ♀, 40 mm; La Plata Island, Ecuador; sand, shale, rock, in 45–55 fms; dredge; Hancock Galapagos Expedition, Sta. 212–34; 10 February 1934.

Description: Cornea bilobed, outer margin of eye longer than inner (Fig. 3a); rostral plate pentagonal, elongate, apical spine not extending beyond cornea, anterolateral angles acute but not sharp (Fig. 3a); carapace with marginal carinae on posterior fourth; superior margin of prop-

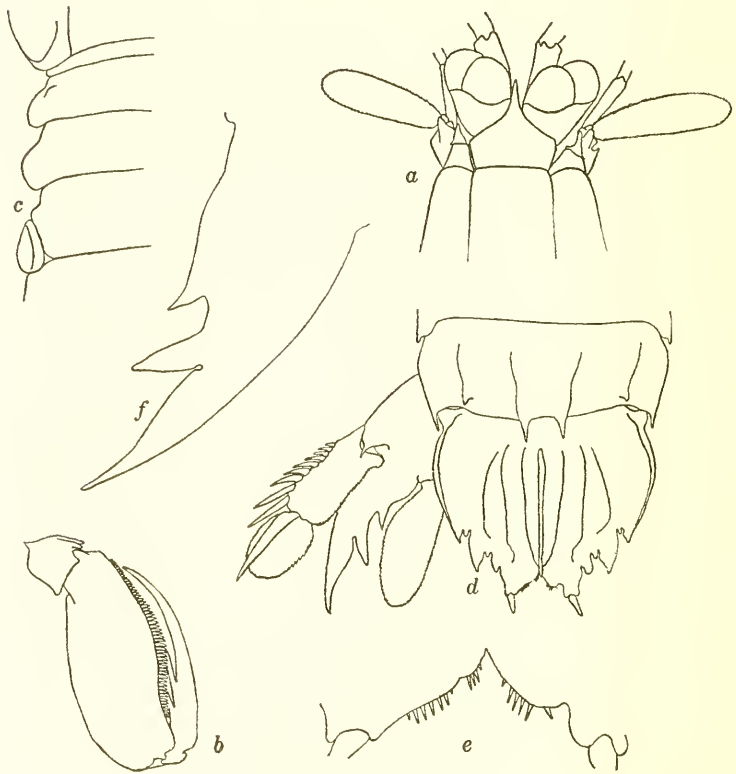


FIGURE 4. *Pseudosquillopsis lessonii* (Guérin), juvenile male, TL 35 mm: *a*, anterior portion of body; *b*, raptorial claw; *c*, lateral processes of exposed thoracic somites; *d*, sixth abdominal somite, telson, and uropod; *e*, submedian denticles of telson (damaged); *f*, basal prolongation of uropod. (Setae omitted).

odus of claw pectinated, dactylus with 3 well-formed teeth (Fig. 3*b*); sixth and seventh thoracic somites with lateral carina, lateral processes produced into posterior spine (Fig. 3*c*); fifth abdominal somite with posterolateral spines; sixth abdominal somite with 3 pairs of spined carinae (Fig. 3*d*); telson with median carina and 5 pairs of dorsal carinae, submedians extending onto submedian teeth (Fig. 3*d*); submedian teeth of telson separate, submedian denticles present 17 (Fig. 3*e*); basal prolongation of uropod produced into 2 spines, outer longer, with smaller third spine on inner margin, remainder of inner margin smooth (Fig. 3*f*).

Pseudosquilla lessonii (Guérin)

Figure 4

Material: 1 ♂, 35 mm; bight on south side of San Juan Bay, Peru; 15°20'S, 75°10'W; bottom dredge; 21 March 1941; M. J. Lobell.

Description: Cornea bilobed, outer margin of eye longer than inner (Fig. 4a); rostral plate pentagonal, length and width subequal, apical spine not extending beyond cornea, anterolateral angles rounded (Fig. 4a); carapace with marginal carinae on posterior fourth; superior margin of propodus of claw pectinate, dactylus with 3 well-formed teeth (Fig. 4b); lateral processes of sixth and seventh thoracic somites lacking carinae at TL 35 mm, lateral processes rounded posterolaterally (Fig. 4c); fifth abdominal somite with posterolateral spine; sixth abdominal somite with 3 pairs of spined carinae (Fig. 4d); telson with median carina and 4 pairs of dorsal carinae, laterals absent at TL 35 mm, submedians interrupted, not extending onto submedian teeth (Fig. 4d); submedian teeth of telson separate, submedian denticles present (damaged in available specimen); basal prolongation of uropod produced into 2 spines, outer longer, with smaller third spine on inner margin, remainder of inner margin smooth (Fig. 4f).

COMPARISON OF JUVENILE STAGES

The juveniles of eastern Pacific *Pseudosquilla* species have assumed most of the characters of adults. The cornea is bilobed, with the outer margin of the eye longer than the inner (Figs. 3a, 4a); there is no trace of the third portion of the cornea found in postlarvae. The rostral plate is similar to that of adults, but in the two eastern Pacific species, the anterolateral angles of the plate in juveniles are unarmed (Figs. 3a, 4a). The marginal carina is present on the carapace; apparently it is well-formed even in the first juvenile stage. The carinae and spines of the sixth abdominal somite are well-developed, although the carinae are not so strong as in adults. Most of the characteristic carinae of the telson (median and five pairs) are present in the juvenile stage of *marmorata*, TL 40 mm, but in the juvenile of *lessonii* examined, TL 35 mm, the lateral carinae are not developed; the juvenile of *lessonii* also lacks the thoracic carinae which are clearly developed in the larger specimen of *marmorata*.

The major difference between the young stages and adults are the presence of small submedian denticles, 17 in *marmorata* and an indeterminate number in *lessonii*, between the widely separate submedian teeth of the telson. In adults of *Pseudosquilla* the submedian teeth are appressed basally and the submedian denticles are completely absent.

The juvenile of *P. marmorata*, even at TL 40 mm, the smallest specimen examined, show the posterolateral spines on the lateral processes of the sixth and seventh thoracic somites (Fig. 3c). This character will distinguish this species from the other species in the genus at all sizes beyond the postlarval stage.

The antennular peduncle is not so long in juveniles of *P. lessonii*, TL 35 mm, as it is in adults, TL 70 or more.

TABLE 2. Characters of different stages of *Pseudosquillaopsis*.

	Postlarvae	Juveniles	Adults
Size (mm)	25-33	20-50	70
Cornea	Trilobed	Bilobed	Bilobed
Rostral plate	Triangular, with long apical spine; rounded laterally	Same	Spined laterally in 2 species
Carinae on carapace	None	Reflected marginals	Reflected marginals
Claw	3 teeth, propodus pectinate	Same	Same
Sixth abdominal somite	2 pairs of non-carinate spines	3 pairs of carinate spines	Same
Carinae on telson	Median	Median and 4-5 pairs	Median and 5 pairs
Submedian denticles of telson	Present	Present	Absent
Basal prolongation of uropod	Long outer spine, with 2 smaller spines on inner margin	Same	Same

The two available juveniles are not of comparable age, as evidenced by the better development of carination in the specimen of *marmorata* at TL 40 mm than in the specimen of *lessonii* at TL 35 mm. Both specimens, however, are clearly subadults, and as such have been used to show transition in development between the postlarva and the adult. Rearing experiments obviously are needed to provide more detailed information on changes in postlarval development and the stages and sizes at which they occur.

GENERAL DISCUSSION

The two postlarvae from the Gulf of Guinea which prompted this study clearly can be identified as the postlarvae of *Pseudosquillaopsis*. They are tentatively identified with *P. cerisii* (Roux, 1828), the only species of the genus known from the eastern Atlantic region. The postlarvae of *P. cerisii*, TL 30-33 mm, are very similar to those of *P. lessonii*, TL 30-32 mm. However, the apex of the rostral plate in the postlarva of *P. cerisii* is shorter and blunter than that of the postlarva of *P. lessonii*, and the distance between the apices of the submedian teeth of the telson is greater in the postlarva of *P. cerisii* than in that of *P. lessonii*.

Characters of postlarvae, juveniles, and adults of members of the genus *Pseudosquillaopsis* are summarized in Table 2. The early stages are distinctive but are clearly referable to *Pseudosquillaopsis*, which was heretofore based on characters afforded by adults only. The most important difference between young specimens and adults is the presence of submedian denticles on the telson in the former and their absence in the adult stage.

Young specimens, possibly including both postlarvae and juveniles, of

P. dofleini (Balss) from Japan have been recorded by Komai (1927). He noted that in the smallest specimen, TL 20 mm, the inner margin of the basal prolongation was unarmed. He also noted that the eyes of his small specimens were subsimilar to those adults. In view of the latter observation, his specimens were probably juveniles rather than postlarvae. From the length of the smallest specimens recorded by him, TL 20 mm, it might be assumed that the postlarvae of *P. dofleini* are smaller than those of the remaining species of the genus.

Adults of the two Eastern Pacific species of the genus, which have the anterolateral angles of the rostral plate armed with spines and also have a smooth inner proximal margin on the basal prolongation of the uropod, are more closely related to each other than to either the Atlantic species or the one found in the Indo-West Pacific region. Indeed, the extra-American species, *P. cerisii* and *P. dofleini*, both of which have spinules proximally on the basal prolongation of the uropod, are extremely difficult to separate.

In his description of *P. dofleini*, Balss (1910) noted that it differed from *P. cerisii* in having the basal prolongation of the uropod armed with spinules; small spinules are definitely present on the basal prolongation in the only specimen of *P. cerisii* I have examined, a male, TL 87 mm, from Naples, Italy, and these spinules have been noted by other authors as well (see Serène, 1962, fig. 2c). The spinules in *P. dofleini* apparently differ from those found in *P. cerisii* in that they increase in size distally, with the distalmost not markedly smaller than the innermost of the three terminal spines on the basal prolongation, whereas all of the spinules are small in *P. cerisii*. In other respects *P. dofleini* and *P. cerisii* resemble each other very closely.

The rostral plate is unarmed anterolaterally in the single specimen of *P. cerisii* which I have examined. Serène (1962, p. 16), in his diagnosis of *Pseudosquilla*, stated that the anterolateral angles were armed in *P. cerisii* and *P. lessonii*, but the plate is rounded anterolaterally in the specimen I examined.

The species placed in *Pseudosquilla* share the following features as adults: cornea bilobed, with outer margin of eye longer than inner; carapace lacking cervical groove, ornamented with short marginal carinae only; propodus of raptorial claw stout, superior margin lined with numerous short, blunt projections; dactylus of claw armed with three teeth; dorsal surface of telson ornamented with median carina and 5 pairs of dorsal carinae; submedian teeth of telson with bases appressed, submedian denticles completely suppressed; basal prolongation of uropod terminating in 2 spines, outer larger, with smaller third spine on inner margin. More detailed diagnoses have been provided by Serène (1962) and Manning (1963), both of whom also commented on the relationships of *Pseudosquilla* to *Parasquilla* and *Pseudosquilla*.

The provisional key to the species of *Pseudosquilla* presented below may have to be revised when more material of *P. dofleini* is available for study.

PROVISIONAL KEY TO ADULTS OF *PSEUDOSQUILLOPSIS*

1. Inner half of basal prolongation of uropod with spinules; rostral plate rounded laterally 2
 Inner half of basal prolongation of uropod smooth or with low, rounded tubercles; rostral plate with lateral spines 3
2. (1) Spinules on inner margin of basal prolongation of uropod increasing in size distally, inner spine of basal prolongation not markedly larger than distalmost spinule
 *P. dofleini* (Balss, 1910): Japan.
 Spinules on inner margin of basal prolongation of uropod small, not markedly increasing in size distally, outermost much smaller than inner spine *P. cerisii* (Roux, 1828): Mediterranean Sea, Gulf of Guinea.
3. (1) Antennular peduncle as long as or longer than carapace; lateral processes of sixth and seventh thoracic somites rounded posterolaterally *P. lessonii* (Guérin, 1830): Peru, Chile, Juan Fernandez Island.
 Antennular peduncle shorter than carapace; lateral processes of sixth and seventh thoracic somites spined posterolaterally
 *P. marmorata* (Lockington, 1877): southern California, Gulf of California, Galapagos Islands.

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